MAEDICA – a Journal of Clinical Medicine
2024; 19(2): 247-254
https://doi.org/10.26574/maedica.2024.19.2.247

MAEDICA - a Journal of Clinical Medicine

ORIGINAL PAPER

# The Impact of Burns Involving Over 50% of Total Body Surface Area – a Six-Year Retrospective Study

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*ABSTRACT*

***Background:*** *Severe burns pose significant therapeutic challenges due to their complex pathophysiology, the potential for life-threatening complications, long-term sequelae and the need for a multidisciplinary approach. In this retrospective study, we aimed to comprehensively analyze burns involving over 50% of the total body surface area (TBSA) treated in our institution over six years.*

***Materials and methods:*** *We performed a retrospective study including 91 patients. The following epidemiological and clinical characteristics were documented: age, sex, comorbidities, admission modality, mechanism of injury, TBSA burned, burn depth, presence of inhalation injury, outcome, length of stay and associated costs.*

***Results:*** *In the study group, subjects had a mean age of 54.4 years (24-93), with a male-to-female ratio of 2.5:1. The median percentage of TBSA burned was 70% (50-99%) and 93.4% of patients had third-degree burns. Inhalation injury was present in 71.4% of patients. Flame burns occurred in 90.1% of patients. Prediction scores were assessed, with 60.4% of patients having an ABSI score above 12. Mortality in our study group was 84.61% and 39.5% of patients died in the first week after burn injury. The most frequent systemic complications were respiratory complications (95.6%), followed by cardiocirculatory (93.4%), metabolic (84.6%), hematological (74.7%), renal (64.8%), hepatic (59.3%) and infectious complications (38.4%).*

***Conclusions:*** *Managing major burns is a highly complex process, which requires specialized care and infrastructure to improve outcomes. Extensive burns, especially over 50% TBSA, have high morbidity and mortality, with factors like age, severity and inhalation injury affecting prognosis. A multidisciplinary approach is essential for treatment, addressing not only the burns but also systemic complications to prevent multiple organ dysfunction syndrome and death.*

**Keywords**: severe burns, demographics, complications, mortality.

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*Article received on the 17th of May 2024 and accepted for publication on the 29th of May 2024*

## INTRODUCTION

Burns are a global public health problem, accounting for an estimated 180,000 deaths annually and the fourth most frequent type of injury worldwide (1). Severe burns pose significant challenges for medical professionals due to their complex pathophysiology, potential for life-threatening complications, long-term sequelae and the need for a multidisciplinary approach. These challenges arise from various factors, including the extensive tissue damage caused by burns, which impairs wound healing and increases the risk of infections. Moreover, the systemic inflammatory response triggered by burn injuries can lead to immune dysfunction, metabolic disturbances and cardiovascular changes, contributing to multi-organ dysfunction. Burn units equipped to provide comprehensive care are essential for optimizing patient outcomes (2, 3).

Prognosis is influenced by several elements, including the time between the occurrence of the burn injury and the admission to a specialized Burn Center where specific treatment is initiated, the percentage of total body surface area (TBSA) affected by burns, the depth of burn wounds, the anatomical location of burns, the mechanism of burn injury, the presence of inhalation injury and potential exposure to toxins, presence of additional traumatic injuries and patient-specific factors including age and preexisting chronic medical conditions (4).

In highly specialized burn centers, advanced medical care and interventions are provided to improve outcomes, but severe burns still pose significant challenges (5). Various prognostic scoring systems have been developed to assess mortality risk in burn patients (6). Some commonly used scoring systems include the abbreviated burn severity index, revised Baux (rBaux) score and Belgian outcome of burn injury score (7-9).

In this retrospective study, we aimed to comprehensively analyze burns exceeding 50% TBSA treated in our institution over six years. By examining epidemiology, clinical outcomes and prognostic factors we sought to enhance our understanding of these challenging cases and inform evidence-based practices for their management. ❑

## MATERIALS AND METHODS

We performed a retrospective study including patients with extensive burns over 50% TBSA who were admitted to the Burn Center of the Emergency Clinical Hospital of Bucharest for six years between 1st January 2018 and 31st December 2023. Inclusion criteria for patients in our study were the referral to our burn center within 72 hours postburn injuries, age>18 years and percentage of TBSA burned ≥50%. Exclusion criteria were late transfer >72 hours, percentage of TBSA burned <50% and subjects with missing data. The following epidemiological and clinical characteristics were documented: age, sex, comorbidities, hospital of primary treatment, mechanism of injury, burn surface, burn wounds' depth, presence of inhalation injury, length of stay in the burn center and patients' outcome. Wallace's rule of nines for adults was used as a tool to assess the surface of burns (10). We calculated our study group's ABSI score, rBaux score and BOBI score (7-9).

Upon admission to the Burn Centre, the initial focus was on stabilizing the patient and addressing immediate concerns such as airway compromise, fluid resuscitation, pain management and wound assessment. Intravenous fluid resuscitation was initiated promptly following the Parkland formula proposed by Charles R. Baxter and adjusted based on urine output (with a target of an hourly urine output at 0.5 mL/kg/h), the vital signs and laboratory parameters (11). In cases where inhalation injury was suspected, diagnostic tools like bronchoscopy, arterial blood gas analysis and chest imaging were employed to confirm the diagnosis and assess the severity of airway involvement.

In the emergency setting, surgical interventions consisted of escharotomies or fasciotomies. Once the patient was stabilized, further surgical interventions consisting of burn wound excision and covering with autologous skin grafts were planned based on the extent and severity of the burn injury. Routine burn wound care was performed daily, adhering to our standardized unit protocols for dressing changes and wound management.

Microbiological assessment was conducted on admission and periodically during hospitalization, depending on clinical suspicion and risk factors (using swab cultures from the burn wounds, sputum cultures, endotracheal aspirate, blood cultures, urine cultures, and cultures from catheter tips). Sepsis and infections in burns were de-

fined according to the American Burn Association Consensus Conference from 2007 (12).

Systemic complications were registered in our study group, adapted after the criteria established by Marshall *et al* for multiple organ dysfunction syndrome (13).

Data collected during the study were compiled into an Excel database and statistically analyzed using the IBM SPSS version 29.0 software package. P-values of $<0.05$ were considered statistically significant. Receiver operator characteristics (ROC) analysis was conducted to evaluate the discriminatory power of scoring systems regarding mortality (14).

The study was conducted following the Declaration of Helsinki, and the protocol was approved by the Hospital Ethics Committee of Bucharest Emergency Clinical Hospital. ❑

## RESULTS

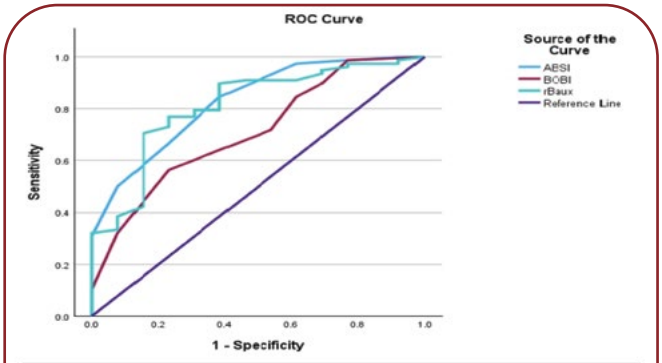
Over the six-year study period, 484 patients were admitted to our Burn Center, among which 91 (18.8% of total number of patients) met the inclusion criteria and presented a burn surface over 50% TBSA.

The 91 patients had a mean age of 54.4 ±17.3 years, ranging from 24 to 93 years. In our study group, 71.43% of subjects were males, with a male-to-female ratio of 2.5:1. The median percentage of TBSA burned was 70%, ranging from 50% to 99%, and 93.41% of patients had third-degree burns. Inhalation injury was identified in 71.42% of patients. Regarding the burn mechanism, flame burns were the most common type of burns, occurring in 90.11% of patients. The most frequently affected body areas were the upper limbs (97.80%), the torso (92.31%) and the lower limbs (90.11%). Among the 91 patients, 67 (73.62%) were referred to our Burn Unit from other hospitals located in different regions of the country (Table 1).

Prognostic scores were assessed. In our study, the ABSI score was above 12 in 60.44% of patients and 10-11 in 31.87% of subjects. The median rBaux score was 138, with higher values of the median rBaux score in the non-survival group than the survival one (141 *versus* 110). Among the 91 patients, 47 (51.64%) had a BOBI score ≥7 points, corresponding to a mortality equal to or greater than 75%. Also, the discriminative power of prognostics scores (ABSI, rBaux and BOBI) was assessed by receiver operating characteristics curve analysis (Figure 1). ROC analysis showed AUC was 0.828 (0.713-0.942) for the ABSI score and 0.812 (0.688-0.936) for the revised Baux score, both indicating conside-

**TABLE 1.** Demographics and clinical characteristics of study patients

| Variables | Classification | Number of patients | Proportion (%) |
|---|---|---|---|
| Sex | Female | 26 | 28.57 |
| | Male | 65 | 71.43 |
| Age (years) | 20-40 | 20 | 21.98 |
| | 41-60 | 38 | 41.76 |
| | 61-80 | 27 | 29.67 |
| | >80 | 6 | 6.59 |
| Mechanism of injury | Flame | 82 | 90.11 |
| | Electric | 6 | 6.59 |
| | Scalds | 3 | 3.30 |
| Burn setting | Domestic accident | 76 | 83.52 |
| | Self-inflicted | 12 | 13.19 |
| | Assault | 1 | 1.10 |
| | Work-related | 2 | 2.20 |
| % TBSA burned | 50-60 | 36 | 39.56 |
| | 61-70 | 15 | 16.48 |
| | 71-80 | 19 | 20.88 |
| | 81-90 | 17 | 18.68 |
| | 91-100 | 4 | 4.40 |
| Third-degree burns | Yes | 85 | 93.41 |
| | No | 6 | 6.59 |
| Inhalation injury | Yes | 65 | 71.42 |
| | No | 26 | 28.58 |
| Burn site | Head | 78 | 85.71 |
| | Neck | 70 | 76.92 |
| | Torso | 84 | 92.31 |
| | Upper limbs | 89 | 97.80 |
| | Lower limbs | 82 | 90.11 |
| Type of admission | Direct admission | 24 | 26.4 |
| | Transfer from other hospitals | 67 | 73.6 |
| Survival | Non-survivors | 77 | 84.61 |
| | Survivors | 14 | 15.39 |




Area Under the ROC Curve

| Test Result Variable(s) | Area | Std. Error | Asymptotic Sig. | Asymptotic 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower bound | Upper bound |
| ABSI | .828 | .058 | <0.001 | .713 | .942 |
| rBaux | .812 | .063 | <0.001 | .688 | .936 |
| BOBI | .711 | .074 | 0.004 | .566 | .856 |

**FIGURE 1.** AUC curve for ABSI, revised Baux (rBaux) and BOBI scores

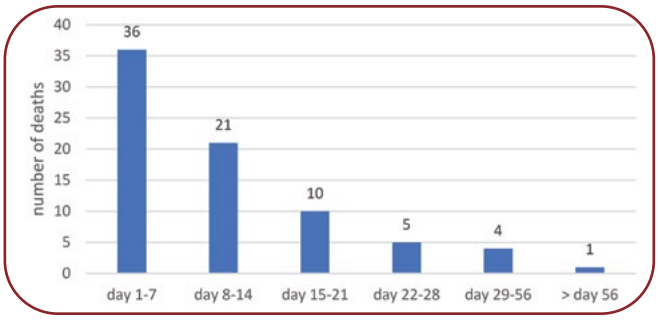



**FIGURE 2.** Time of death after burn injury

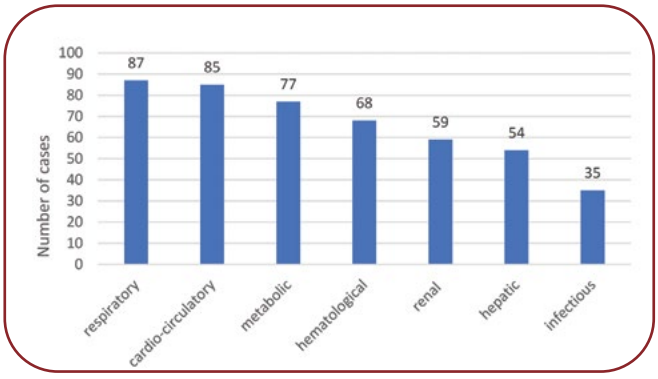



**FIGURE 3.** Distribution of systemic complications

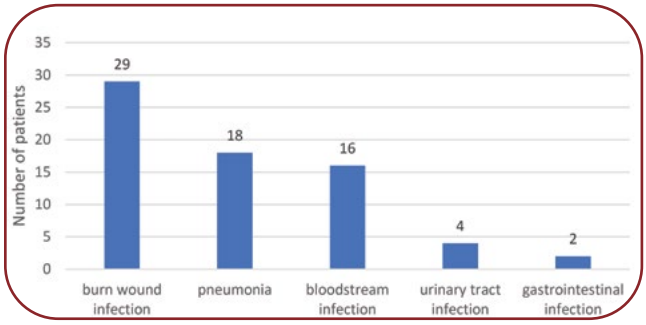



**FIGURE 4.** Distribution of infectious complications

rable accuracy. The BOBI score had an AUC of 0.711 (0.566-0.856), indicating a fair accuracy.

Regarding patient outcome, the mortality in our study group was 84.61% and 36 (39.5%) subjects died in the first week after burn injury (Figure 2). Patients with more extensive burns ($p<0.01$) and older onets ($p<0.05$) had shorter survival periods. There was no association between gender and mortality in our study group.

During hospital stay, burn patients developed a series of systemic complications, as shown in Figure 3.

Particularly, infectious complications were assessed in our study, focusing on their timeline and associated outcomes, and we identified 35 patients (38.4%) who developed infections (Figure 4). Out of the 36 patients who died in the first week post-burn injury, in four (11.1%) patients mortality was associated with sepsis. Out of the 41 patients who died after the first week, mortality was associated with sepsis in 19 (46.3%) subjects. In the survival group (14 patients), 12 (85.7%) patients had infectious complications that were successfully treated.

Out of the 91 patients, 87 (95.6%) subjects required intubation and mechanical ventilation before admission to our Burn Center. In our study group, the mean number of hours of mechanical ventilation was 217.8 hours, ranging from 5 to 1480 hours. Tracheostomy was required in 19 (20.8%) patients, with the main indication for tracheostomy being the need for prolonged mechanical ventilation (17 patients). An indication for urgent tracheostomy due to difficult intubation was present in two patients. Inhalation injury was diagnosed by bronchoscopy in 71.42% of patients.

Regarding surgical treatment, patients underwent an average of 1.9 surgeries, with the number ranging from 0 to 6. These procedures included escharotomies or fasciotomies, burn wound excision and skin grafting using autografts.

The length of hospitalization was assessed for both survivors and deceased patients. The median length of stay was eight days in the non-surviving group and 54 days in the survivor's group. ❑

## DISCUSSION

Major burns present a significant challenge for healthcare systems, regardless of the level of development or standards of care. Despite notable advancements in burn care achieved in recent decades, treating patients with extensive burns continues to pose significant challenges which require coordinated efforts in prevention, treatment and long-term care to mitigate their impact on individuals and society (15). According to guidelines from the American Burn Association (ABA), specialized care in dedicated burn centers is recommended for patients with more severe burn injuries. Recommendations for transfer to the Burn Center include patients with full-thickness burns, partial thickness ≥10% TBSA, burns of the face, hand,

feet, perineum or major joints, suspected inhalation injury, concomitant trauma, preexisting severe illnesses, all chemical burns and high-voltage electrical injuries (16).

We reviewed the existing literature and corroborated it with data available in our institution to analyze a series of parameters that modify the outcome in burn patients with burn surfaces exceeding 50% TBSA. We identified 91 patients, among whom the median percentage of TBSA burned was notably elevated up to 70% (ranging from 50% to 99%). According to the literature data, an increased surface of burns is a significant predictor of mortality (4, 17, 18). In a multicenter prospective cohort study conducted by Jeschke MG *et al* in North America (5), mortality risk surged beyond a threshold of approximately 54% TBSA burned, signifying a considerable increase in the likelihood of death, multiple organ failure (MOF) was significantly associated with burns encompassing approximately 50% TBSA, while the risk of encountering at least two burn wound infections/contaminations escalated notably with burns affecting around 45% TBSA. Moreover, the likelihood of sepsis elevated substantially when burns involved roughly 50% TBSA.

The mechanism of burns is another factor that can significantly influence the severity of the injuries. In our study, most burns were caused by flames (n=82, 90.11%), while electrical injuries (n=6, 6.59%) and scalds (n=3, 3.30%) were only the causes of a minority of burns. Flame injuries occurred mostly from gasoline ignition caused by improper handling of gasoline, setting fire to crops, explosions due to liquefied petroleum gas cylinders, or gas central heating malfunction. The majority of burns were domestic accidents (n=76, 83.52%), while self-inflicted burns (n=12, 13.19%) and work-related injuries were less frequent (n=2, 2.2%). Most injuries in our study were accidental and could have been prevented. Flame burns are also the leading cause of burn injuries in other studies on the adult population (19-20). Previous studies correlated flame burns with a higher mortality rate, which may be attributed to their association with more extensive and deeper burns, as well as the presence of inhalation injury (21, 22).

Flame burns are frequently associated with inhalation injury, which in our study were found in 71.4% of patients. Fiberoptic bronchoscopy is considered the gold standard for diagnosing and assessing the severity of airway inhalation injury and can play a role in predicting the clinical course of patients with airway injury and in detecting complications early on (23). Data from the literature also reported inhalation injury as a negative prognostic factor in severe burns (24, 25).

For patients with major burns, respiratory support, including mechanical ventilation, is often a necessary component of treatment due to the severity of their condition. In our study, we noticed that 95.6% of patients required mechanical ventilation. In 20.8% of patients, a tracheostomy was performed. In our study group, the mean number of hours of mechanical ventilation was 217.8 hours, ranging from 5 to 1480 hours. A study by Xiao *et al* identified several risk factors for prolonged mechanical ventilation, including the presence of inhalation injury, ABSI score, % TBSA burned, albumin and lactic acid levels at admission (26). Extended mechanical ventilation can lead to complications such as ventilator-associated pneumonia, ventilator-associated lung injury, complications related to prolonged sedation and immobility, and it is often indicative of severe injury and systemic complications. In our study group, 19.7% of patients were diagnosed with pneumonia and all subjects were mechanically ventilated at the time of diagnosis.

Regarding burn depth, a paramount prognostic determinant of burn severity, 93.41% of patients had third-degree burns. A common practice in our study group was to excise all deep dermal and full-thickness burned areas within the first 72 hours of injury after the burn injury, and to harvest autologous split-thickness skin grafting for wound coverage, using mesh grafting or the Meek micrografting technique. Early burn wound excision and covering with autologous skin grafts is a standard surgical procedure in the management of severely burned patients (27, 28). Patients with extensive burns commonly experience systemic complications both during hospitalization and in the long term, including the rehabilitation period. These complications pose diagnostic challenges and necessitate early diagnosis and prompt multidisciplinary treatment to enhance patient outcomes (29).

In our study group, cardiocirculatory complications were found in 93.4% of patients. Previously published studies showed that burn inju-

ries cause significant hemodynamic and cardiac disruptions, influenced by various factors such as plasma volume loss, smoke inhalation, hypoxia, hormone release and inflammatory cytokines (30, 31). Cardiac dysfunction has been consistently linked to worse outcomes in both adult and pediatric populations affected by burns (32).

Metabolic complications were encountered in 84.6% of our patients. Previous studies showed that hypermetabolism was a key feature of the body's stress response to burns, with an increased metabolic rate, burn-induced muscle wasting, cachexia and insulin resistance (33).

Hematological complications, including anemia, thrombocytopenia and coagulopathies, were present in 74.7% of our patients. The development of coagulopathy is linked to the extent of burn injury, as measured by the percentage of total body surface area affected, the presence of full-thickness burns and inhalation injuries (34). Severely burned patients often face acute blood loss during surgeries and procedures, as well as challenges related to anemia of critical illness, characterized by blunted erythropoiesis due to the body's response to severe injury (35).

Renal complications were diagnosed in 64.8% of subjects included in our study. Acute kidney injury in burn patients can manifest at two distinct time points: early during the resuscitation phase, due to hypoperfusion and under resuscitation, cardiac dysfunction, inflammatory mediators and nephrotoxic drugs, or later as a complication secondary to sepsis or septic shock (36, 37).

Hepatic complications were encountered in 59.3% of patients. A study by Jescke et al showed that immediately after burn, the damage of the liver was associated with hepatic edema formation and a subsequent increase of the liver enzymes and acute-phase proteins, while serum bilirubin increased at one week and two weeks after burn injury (38). Other causes of liver damage are hypoperfusion during the resuscitation phase, release of hepatotoxic substances, intrahepatic cholestasis and hepatic apoptosis due to an ischemia-reperfusion mechanism and proinflammatory cytokines (39).

Infections are the most common and significant complication in burn patients (40-41), who are particularly susceptible to sepsis due to compromised skin barriers and immune suppression. Out of the total 91 patients, 35 (38.4%) subjects experienced infections. In our study, we observed that infections were not the primary complication. This was because the selected sample comprised patients with extensive burns, and they predominantly developed other organic dysfunctions due to the severity of the burns. Part of the patients in our study rapidly deceased after the injury due to the severity of the burn shock and they did not live long enough to develop infections. The most common types of infections comprised burn wound infections, which affected 29 (31.8%) patients, followed by pneumonia in 18 (19.7%) patients, bloodstream infections in 16 (17.5%) patients and urinary tract infections in four (4.3%) patients.

In our specific study group, mortality was very high (84.6%) and we identified several risk factors for negative prognosis: the median percentage of TBSA burned was 70%, more than three-quarters of patients were over 40 years old, 93% of subjects had extensive third-degree burns and inhalation injury was present in almost three-quarters of patients. The majority of studies in the literature included all patients admitted to a certain burn center, regardless of their burned total body surface area, rendering comparison of our study group with other cohorts difficult.

A particularity encountered by us is that our institution is the only specialized burn center for adults in Romania, to which patients with the most severe burn injuries are referred from all across the country for treatment. This situation differs from other countries, where multiple burn centers are serving individual geographic regions. Transferring patients from long distances and late admission can lead to loss of the critical moment of initial resuscitation, which can significantly impact prognosis. More than two-thirds of patients included in the present study were referred to our Burn Center from other regions in our country and were in severe shock on admission because of long-distance transfer and inadequate fluid resuscitation.

Several predictive scores have been developed to assess burn severity and forecast mortality in burn patients. Using risk assessment models can be an effective strategy for identifying the subset of individuals who require additional attention in terms of therapy, resource allocation and cost management. We usually assess the ABSI score at admission for severity prediction.

In our study, the ABSI score was above 12 (survival probability < 10%) in 60.4% of patients and 10-11 (survival probability 20-40%) in 31.8% of patients. The median ABSI score was higher in the non-survival group than the survival one (12.5 versus 10). A study by Usmani *et al* showed that survival was 83.33% in patients with an ABSI score of 9-10% and 0% when the ABSI score was >11 (42). In our study group, the AUC value for the ABSI score – 0.828 (0.713-0.942) – showed a considerable degree of accuracy. Nevertheless, these models have a critical limitation: they do not incorporate comorbidities in burn patients and overlook mortality risks in critically ill individuals (43).

The present study has several limitations. Primarily, its reliance on a single-center experience restricts the generalizability of findings, as practices and resources vary across different institutions. Moreover, burn patients are referred to our Burn Centre from all around the country, leading to a selection of the most severe cases, sometimes with patients beyond therapeutic resources. Additionally, transporting patients over extended distances to reach our Burn Centre can worsen prognosis since it involves a delay in specialized treatment. Another drawback of our investigation was that the study was conducted retrospectively.

## CONCLUSIONS

The management of major burns presents a serious burden for healthcare systems worldwide, demanding specialized resources, expertise and infrastructure. Our analysis reveals the grim reality of high mortality rates among patients with burns over 50% TBSA, with significant determinants including the extent of the burn, patient's age and presence of inhalation injury. Regarding patient outcome, the mortality in our study group was 84.6% and 39.5% of patients died in the first week after burn injury. In those with burns over 50% TBSA, we encountered serious systemic and infectious complications. Prompt diagnostic and adequate treatment of these severe complications is mandatory to avoid multiple organ dysfunction syndrome and subsequent death. Burn centers play a critical role in providing specialized treatment for severe burn injuries, significantly improving survival rates and recovery outcomes through comprehensive care and rehabilitation services. The high proportion of patients with extensive burns referred to our burn center from distant regions, often in severe shock due to delayed access to specialized care, highlights the need for systemic improvements in the pre-hospital management of burn injuries in Romania to optimize patient outcomes. ❑

*Institutional Review Board statement: This study was approved on 29 January 2024 by the Hospital Ethics Committee of Bucharest Emergency Clinical Hospital (approval number 793).*

*Informed consent statement: Informed consent was obtained from all subjects involved in the present study.*

*Conflicts of interest: none declared.*

*Financial support: none declared.*

# References

1. **Burns (Internet).** World Health Organization. 2018 Available from: https://www.who.int/news-room/fact-sheets/detail/burns.
2. **Żwierełło W, Piorun K, Skórka-Majewicz M, et al.** Burns: Classification, Pathophysiology, and Treatment: A Review. *Int J Mol Sci* 2023;24:3749.
3. **Markiewicz-Gospodarek A, Kozioł M, Tobiasz M, et al.** Burn Wound Healing: Clinical Complications, Medical Care, Treatment, and Dressing Types: The Current State of Knowledge for Clinical Practice. *Int J Environ Res Public Health* 2022;19:1338.
4. **Brusselaers N, Monstrey S, Vogelaers D, et al.** Severe burn injury in Europe: a systematic review of the incidence, etiology, morbidity, and mortality. *Crit Care* 2010;14:R188.
5. **Jeschke MG, Pinto R, Kraft R, et al.** Morbidity and survival probability in burn patients in modern burn care. *Crit Care Med* 2015;43:808-815. doi: 10.1097/CCM.0000000000000790.
6. **Lip HTC, Idris MAM, Imran FH, et al.** Predictors of mortality and validation of burn mortality prognostic scores in a Malaysian burns intensive care unit. *BMC Emerg Med* 2019;19:66.
7. **Ryan CM, Schoenfeld DA, Thorpe WP, Sheridan RL.** Objective estimates of the probability of death from burn injuries. *N Engl J Med* 1998;338:362-366.
8. **Osler T, Glance LG, Hosmer DW.** Simplified estimates of the probability of death after burn injuries: extending and updating the baux score. *J Trauma* 2010;68:690-697.
9. **Belgian Outcome in Burn Injury Study**

**Group.** Development and validation of a model for prediction of mortality in patients with acute burn injury. *Br J Surg* 2009;96:111-117.
10. **Moore RA, Popowicz P, Burns B.** Rule of Nines. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing. February 12, 2024.
11. **Mehta M, Tudor GJ.** Parkland Formula. (Updated 2023 Jun 19). In: *StatPearls.* Treasure Island (FL): StatPearls Publishing. 2024 Jan.
12. **Greenhalgh DG, Saffle JR, Holmes JH 4th, et al.** American Burn Association consensus conference to define sepsis and infection in burns. *J Burn Care Res* 2007;28:776-790.
13. **Marshall J.** The multiple organ dysfunction sydrome. In: *Surgical Treatment: Evidence-based and problem-oriented.* Munich: Zuckschwerdt Verlag. 2001, pp. 780-785.
14. **Çorbacıoğlu ŞK, Aksel G.** Receiver operating characteristic curve analysis in diagnostic accuracy studies: A guide to interpreting the area under the curve value. *Turk J Emerg Med* 2023;23:195-198.
15. **Kearney L, Francis EC, Clover AJ.** New technologies in global burn care – a review of recent advances. *Int J Burns Trauma* 2018;8:77-87.
16. **American College of Surgeons Committee on Trauma.** Burn center referral criteria from guidelines for the operation of burn centers. In: *Resources for optimal care of the injured patient.* Chicago, IL: American College of Surgeons. 2006, pp 79-86.
17. **Hahn B, Roh SA, Price C, et al.** Estimates of Total Burned Surface Area by Emergency Department Clinicians and Burn Specialists. *Cureus* 2020;12:e9362. doi: 10.7759/cureus.9362.
18. **AlAlwan MA, Almomin HA, Shringarpure SD, et al.** Survival From Ninety-Five Percent Total Body Surface Area Burn: A Case Report and Literature Review. *Cureus* 2022;14:e21903. doi: 10.7759/cureus.21903.
19. **Othman N, Kendrick D.** Epidemiology of burn injuries in the East Mediterranean Region: a systematic review. *BMC Public Health* 2010;10:83. doi: 10.1186/1471-2458-10-83.
20. **Ibarra Estrada MÁ, Chávez Peña Q, García Guardado DI, et al.** A 10-year experience with major burns from a non-burn intensive care unit. *Burns* 2014;40:1225–1231.
21. **Aldemir M, Kara IH, Girgin S, Güloglu C.** Factors affecting mortality and epidemiological data in patients hospitalised with burns in Diyarbakir, Turkey. *S Afr J Surg* 2005;43:159-162.
22. **Papp A.** The first 1000 patients treated in Kuopio University Hospital Burn Unit in Finland. *Burns* 2009;35:565-571. doi: 10.1016/j.burns.2008.03.006.
23. **Mlcak RP, Suman OE, Herndon DN.** Respiratory management of inhalation injury. *Burns* 2007;33:2-13. doi: 10.1016/j.burns.2006.07.007.
24. **Dries DJ, Endorf FW.** Inhalation injury: epidemiology, pathology, treatment strategies. *Scand J Trauma Resusc Emerg Med* 2013;21:31. doi: 10.1186/1757-7241-21-31.
25. **Jones SW, Williams FN, Cairns BA, Cartotto R.** Inhalation Injury: Pathophysiology, Diagnosis, and Treatment. *Clin Plast Surg* 2017;44:505-511. doi: 10.1016/j.cps.2017.02.009.
26. **Xiao K, Chen WX, Li XJ.** Analysis of risk factors of prolonged mechanical ventilation in patients with severe burn injury. *Clin Respir J* 2023;17:791-798. doi: 10.1111/crj.13673.
27. **Gacto-Sanchez P.** Surgical treatment and management of the severely burn patient: Review and update. *Med Intensiva* 2017;41:356-364. doi: 10.1016/j.medin.2017.02.008.
28. **Nițescu C, Calotă DR, Florescu IP, Lascăr I.** Surgical options in extensive burns management. *J Med Life* 2012;5(Spec Issue):129-136.
29. **Nielson CB, Duethman NC, Howard JM, et al.** Burns: Pathophysiology of Systemic Complications and Current Management. *J Burn Care Res* 2017;38:e469-e481.
30. **Abu-Sittah GS, Sarhane KA, Dibo SA, Ibrahim A.** Cardiovascular dysfunction in burns: review of the literature. *Ann Burns Fire Disasters* 2012;25:26-37.
31. **Tapking C, Popp D, Herndon DN, et al.** Cardiac Dysfunction in Severely Burned Patients: Current Understanding of Etiology, Pathophysiology, and Treatment. *Shock* 2020;53:669-678. doi 10.1097/SHK.0000000000001465
32. **Williams FN, Herndon DN, Suman OE, et al.** Changes in cardiac physiology after severe burn injury. *J Burn Care Res* 2011;32:269-274.
33. **Porter C, Tompkins RG, Finnerty CC, et al.** The metabolic stress response to burn trauma: current understanding and therapies. *Lancet* 2016;388:1417-1426.
34. **Nikolaidou E, Kakagia D, Kaldoudi E, et al.** Coagulation Disorders And Mortality In Burn Injury: A Systematic Review. *Ann Burns Fire Disasters* 2022;35:103-115.
35. **Posluszny JA Jr, Gamelli RL.** Anemia of thermal injury: combined acute blood loss anemia and anemia of critical illness. *J Burn Care Res* 2010;31:229-242.
36. **Fagan SP, Bilodeau ML, Goverman J.** Burn intensive care. *Surg Clin North Am* 2014;94:765-779.
37. **Palmieri T, Lavrentieva A, Greenhalgh DG.** Acute kidney injury in critically ill burn patients. Risk factors, progression and impact on mortality. *Burns* 2010;36:205-211. doi: 10.1016/j.burns.2009.08.012.
38. **Jeschke MG, Micak RP, Finnerty CC, Herndon DN.** Changes in liver function and size after a severe thermal injury. *Shock* 2007;28:172-177. doi: 10.1097/shk.0b013e318047b9e2.
39. **Gong Y, Long X, Xu H, et al.** The changes and prognostic value of liver function in young adults with severe burn: A retrospective observational study. *Medicine* (Baltimore) 2018;97:e13721.
40. **Lachiewicz AM, Hauck CG, Weber DJ, et al.** Bacterial Infections After Burn Injuries: Impact of Multidrug Resistance. *Clin Infect Dis* 2017;65:2130-2136.
41. National Burn Repository 2016 Report. Chicago, IL: American Burn Association. 2016.
42. **Usmani A, Pipal DK, Bagla H, et al.** Prediction of Mortality in Acute Thermal Burn Patients Using the Abbreviated Burn Severity Index Score: A Single-Center Experience. *Cureus* 2022;14:e26161. doi: 10.7759/cureus.26161.
43. **Masud D, Norton S, Smailes S, et al.** The use of a frailty scoring system for burns in the elderly. *Burns* 2013;39:30-36.